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AUTHOR Mauney, Donna
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ABSTRACT

The new mathematics standards recently issued by New York (NY) require that all educators participate in the mathematical development of their students. This paper argues that what is being written about mathematics can be used in any subject. It explains that an investigation of writings about mathematics led to the discovery that it can be used in any subject. A number of mathematics topics were discovered that could be taught while teaching social studies. The paper reviews the literature that influenced these thoughts. It also demonstrates how one social studies educator has begun to teach mathematics during social studies. Contains 9 references. (Author/BT)

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Infusing Mathematics into Social Studies.

by Donna Mauney

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Infusing Mathematics into Social Studies

Donna Mauney

Learning of the New Mathematics Standards for New York City lead this writer to investigate what is being written about mathematics and how it can be used in any subject. I discovered a number of math topics that could be taught while teaching Social Studies. This article will review the literature that influenced my thoughts. It will also demonstrate how I have begun to teach Math during Social Studies.

What is the Connection?

The uses of mathematics in many academic areas are rather subtle. Often teachers of Social Studies fail to realize the math skills required to do what they view as basics. Based upon this writer's interviews with peers, some common complaints are: children are unable to read and understand a time line; they are unable to find places on a map; they don't seem to understand scale; they have difficulty reading, interpreting and creating graphs; and guessing or estimating seems to be foreign. Finally, oral and written skills are sorely lacking when communicating ideas related to these skills. Instead of looking into the mathematics of these areas, the Social Studies teacher continues to teach and reteach into frustration.

This writer proposes that the Social Studies teacher does a reverse and simply teach the math skills needed for the child to become competent in these areas. Thus, the question becomes what mathematical strand is being employed and how can it be integrated into a Social Studies lesson?

The time line requires the knowledge and understanding of negative and positive integers and the decimal system. What can the Social Studies teacher do to teach or reinforce what the student has learned in math? The issue of location involves coordinate geometry. How can the Social Studies teacher teach or reinforce this knowledge? Competence in the area of scale requires comprehension of ratio; the use of grid paper; measurement (metrics and customary); the geometric concept of area; and how to use a ruler correctly. What can the Social Studies professional do to develop these skills in the classroom?

Interpreting graphs and charts requires the understanding of probability, statistics (data collection) and fractions. Finally, estimating and guessing may appear to be quite natural to the adult, but not to the child who is constantly admonished to not guess nor to approximate. What activities can the Social Studies teacher provide to develop competence in these areas of Math?

New Standards, Old Problems

A recent study by the AFT declared gaps in Social Studies performance nationwide. Are some of these gaps in direct relationship to the lack of the identified skills or that of general knowledge or both? Finding very little research materials that adapt math concepts to Social Studies, I decided to develop and evaluate lessons that do address a concern: what math techniques and materials can be effectively used in the Social Studies classroom?

The new math standards recently issued by the City of New York requires that all educators participate in the mathematical development of the students we educate. This becomes a problem for those who think they are not "mathematical". Although, the average elementary teacher can incorporate mathematics into weekly lesson plans easily and painlessly, they often avoid doing so. Another problem is that children are not scoring well on the social studies tests. If social studies professionals ignore the importance of math education as it relates to their own subject area, this writer suspects that the children will continue to score poorly. A third problem is the innate design of the Middle School. Thus, I believe, teachers of two different disciplines must learn to

develop lessons that balance and reinforce what each teacher is teaching within the Middle School setting.

Clearly, the Social Studies professional must evaluate what mathematical strands are needed to develop student competence in the areas that concern them. The teacher may want to identify and teach each skill within the strands or concentrate on specific skills that encompass a number of strands. Thus, this paper will address two strands, geometry and statistics as they both allow children to integrate mathematics into real world learning. The question is how and how effective is teaching math from a social studies point of view? What will be the outcome of hands on materials that explain the two-dimensional world that teachers know and love . . . the textbook? How substantially better will children understand data collection, predicting, planning and decision making based upon their reality versus textbook graphs?

Kids Declare Social Studies is "Boring"

We often say social studies is boring to the students because they lack the skills that would help him better appreciate the topic. Before we think math, we say poor reading comprehension and study habits are the culprits. However, consider this. According to the NCTM's March, 1989 position paper, "Knowing mathematics means being able to use it in purposeful ways. . . (p. 5). Often social studies teachers fail to plan for students who do not know how to do this. For example, the students' responses to a simple question "How old was President Lincoln when he was assassinated?" could leave the teacher quite perplexed. Something, taken for granted by the teacher is just not there. Is this the math teacher's fault? Of course not. The children know how to add and subtract. They simply do not know how to use an algorithm in a purposeful way that will yield the results the social studies teacher is expecting.

The NCTM continues with ". . . To learn mathematics, students must be engaged in exploring, conjecturing, and thinking

rather than only in rote learning of rules and procedures. . . (p. 5). Since the algorithm is known, the social studies teacher can present a quick math lesson (starting with a student's birth date) on how to subtract a past date from a present date to determine the answer to the Lincoln question or any similar question.

Any math teacher would agree, ". . . Mathematics learning is not a spectator sport. When students construct personal knowledge derived from meaningful experiences, they are much more likely to retain and use what they have learned(p. 5). Understanding this, the social studies teacher's lesson on determining length of life can have a lasting impression and, again, reinforce an algorithm that could be applied to similar situations (i.e. "How long did the Moores rule Spain? or "How long did it take the television industry to develop High Definition Television?")

Finally, the NCTM announced a new role for the teacher. . . not the math teacher per se. This role is to provide. . . "experiences that help students make sense of mathematics, to view and use it as a tool for reasoning and problem solving (p. 5)." Therefore, it should be permissible for the social studies teacher to conduct math lessons that help students translate what they know, mathematically, to social studies.

Obviously, impressed by the NCTM's position, Stephen S. Willoughby's book Mathematics Education for a Changing World(1990), addresses why mathematics education needs to change. To support his argument, he used the NCTM, Burns and Tank extensively with vague references to social studies. He asserts "All of mathematics can, and should, be derived from something that is real to the learner. . . For older students, the reality may be the natural or social sciences, puzzles, or even some part of mathematics itself(p. 11)." However, his discussion of space applications(pp 49 - 50) affirms how the social studies teacher can incorporate mathematics into a weekly lesson plan. . . "the most common applications of mathematics to the world around us involve number and space(p 49)," yet space is often neglected or taught

in a two - dimensional fashion. Another writer agrees, stating that "this traditional instruction in measurement falls short in helping children develop an understanding of space." (Nitabach & Lehrer, 1996).

Nitabach and Lehrer write from the geometry, 'earth measure,' perspective that clarifies Willoughby's idea of space. They argue that plane geometry and learning to use a ruler alone does not develop spatial sense (p 473). It struck this writer that Gardner's idea of spatial intelligence and the author's concept of spatial sense were one in the same. However, Nitabach and Lehrer stress that children learn this as opportunities are provided. Further reading confirmed this. In *Getting Specific About Multiple Intelligences*, Hatch (1997) re-evaluated Gardner's theory, asserting:

Instead of organizing the curriculum around the intelligences, organize around the child. We do not have to teach every child every subject in seven or eight different ways or ensure that every child develops every intelligence. Although we should expose children to a range of activities, every child does not, for example, need to develop musical intelligence or have mathematical or scientific concepts presented in musical form.

On one hand, this writer agrees with Hatch, but disagree on the other. Although individuals may have a natural acuity and interest in a given area, the teacher is obligated to identify them and use them to gear the child toward Willoughby's concept of a liberally educated individual. Thus, spatial intelligence should be developed through direct instruction. This notion can be supported by the comment that "the van Hiele's assert that progress through the levels is more dependent on the instruction received than on age or maturation". (Crowley, p 5 1987)

Another focus of the Willoughby book was that of connections. Whether across the grades (vertical connections) or across the curriculum within each grade, he argued that math connection to all subject areas was a must(pp 71 - 85). It seems his call motivated one individual, Marilyn Burns, and a company called the Cusinaire to meet the challenge. This company is now called Dale Seymour Publications and is

currently publishing a National Science Foundation approved math program entitled Connected Mathematics. It also continues to offer books and materials long associated with Cusinaire. Its program, developed at Michigan State University is very similar to the Britannica Series selected by JHS 145.

Ms Burns prefaces her 1992 book, About Teaching Mathematics: A K-8 Resource with the following "Research reveals that although students can perform arithmetic computations adequately, they are not able to use their skills to solve problems. . . (p 3)." The social studies teacher could be instrumental in helping children solve real life math problems if they better understood how to integrate math into their lessons.

Willoughby does point out the advantages that the elementary teacher has over the specialized middle school teacher. This teacher has the luxury of teaching across the curriculum on a daily basis. Yet he observed that, often, elementary teachers overlook mathematical connections and compartmentalize the child's daily learning experiences. This continues through the middle school, high school and even college (pp 71 -73). This writer concurs with Willoughby, "A good liberal education does not consist solely of learning a great many things in isolation. A liberally educated person understands the connections between and within various branches of knowledge and is able to think and communicate rationally about them" (p 74).

Math Can Add Spice to the "Boring"

It is important to note that this writer was not always of this persuasion. As a Social Studies teacher, I must admit that I had not previously thought, constructively, in terms of the natural linkage between math and Social Studies. In fact, my own math phobia made me resistant to the idea of integrating mathematics lessons that were sorely needed.

However, reading an article, *Resolving the Continuing Dilemmas in School Geometry* helped this writer come to terms with the fact that although I had "never studied geometry in three dimensions"; had

never "encountered non - Euclidean geometry" and had definitely not "dealt with transformations or vectors" (Usiskin, 1987), I was still capable of integrating two mathematical strands that can develop real world math experiences. Geometry is one of them.

Another writing to influence my thinking was *Geometry: An Avenue for Teaching Problem Solving in Grades K-9* (De Guire, 1987). Her argument for problem solving opportunities really made sense.

Finally, geometry can be used to develop critical thinking and problem solving. It involves "teaching content in meaningful ways so that it can be used in further problems and learning." (DeGuire, p 59 1987) Adhering to DeGuire's article can be misleading as there is the assumption that spatial intelligence is innate or already developed during K - 3. A middle school teacher may feel using manipulative materials burdensome for her and too babyish for the middle schooler. However, using pattern blocks to solve more sophisticated problems in the upper grades seems quite appropriate, for sad but true, a number of children sitting in a middle school classroom simply did not receive such instruction and lack geometric skills.

Most four - six-grade level teachers would hesitate DeGuire's recommendation to use geoboards for problem solving. (p 61) The fear of the misuse of rubber bands abounds and so children, generally, do not get this hands on opportunity. However, there are computer programs that offer similar experiences for the fearful.

A second real world topic that blends well with Social Studies is that of statistics and probability. Many a graduate student can recall this as a course they entered with much trepidation simply because it was, as Willoughby points out, taught in isolation. Clearly recording and interpreting data and creating graphs is connected with prediction, decision making and planning (policy issues that future leaders need to understand).

A quote from M. Burns (p. 59, 1992) should verify this reality:

Statistics is the science or study of data. Statistical studies require collecting, sorting, representing,

analyzing, and interpreting information. The information is then used for predicting, drawing inferences, and making decisions.

Burns further argues that "Learning probability and statistics provides real applications or arithmetic." This writer agrees with Burns' statement that "When basic computational skills are used in context, students have the opportunity to see the advantages and limitations of their calculations. (p 59)

In addition, Wiebe, in his manual of Probability Experiments asserts, "Probability is one of the most widely applicable topics in arithmetic. Probability theory is the mathematical model of aspects of human uncertainty. . . . Probability statements saturate our daily conversation (p 3). He further asserts that the study of probability employs "a broad range of skills in a single, major problem - solving experience." (p.3). He also notes that probability is "intrinsically interesting." Thus keeping a student's interest in math and related problem - solving high.

It seems sound doctrine to teach children concepts of statistics in the Social Studies classroom. As with earth measure, there is no reason for the Social Studies teacher to assume that the Math teacher has already taught these relative concepts, nor is there any good reason to assume that it is the Math teacher's responsibility.

The importance is that of connections to the real world and providing children with the opportunity to help them develop various intelligence that will assist them in making sense of the world before them. Hands on and active engagement in ideas generated (once presented and guided by the teacher) can produce amazing results.

An Application: Infusing Mathematics into Social Studies

Using the concept of probability as a spring board, a Social Studies teacher can take the children to another level . . . data collection and decision - making. Using an already developed vocabulary, the teacher can go on to words such as survey, titles, and axis. Such concepts, inevitably, guide

children through the KWL (What I Know; What I want to know; What I have learned) principles that Content Area teachers often use for reading and comprehending text, but fail to use when it comes to mathematical applications.

This writer, who is a Social Studies professional at JHS 145, has selected one fifth grade class to assess how integrating hands on math activities with Social Studies can improve student understanding of skills required to master both the new Social Studies and Math tests they will encounter in sixth and eight grades, respectively.

In order to infuse Math into Social Studies, one must not only consider the topics, but the materials needed to help children understand what is being taught.

An overhead projector, overhead demonstration materials, transparency film and pens for both teacher and students are not essential, but do add greatly to the presentation of various lessons. I easily modeled how the tools or materials were to be used, and the children genuinely enjoyed coming up and sharing their solutions to a given problem.

Tools such as rulers, protractors and graph paper helped children learn linear measurement, demonstrate scale, make circles and form different types of graphs. Manipulative materials such as square tiles (one inch and one centimeter) and connecting cubes assisted children in constructing bar graphs, solve area and perimeter problems, and better understand scale (This was particularly useful in understanding distance and population per square mile type maps).

In addition, circle fractions provided children with concrete experiences of creating parts of the whole circle. This hands on experience was then translated onto circle graphs. It even encouraged estimating and reasoning. For example, it would not be unusual to hear a student say "Well, I know this is twenty five percent, so just a little more would be twenty seven percent." Those who prefer a more precise measure have mastered using the protractor and love demonstrating that skill.

I found using these materials quite

effective. With a little guidance and practice children learned to read and understand both the standard and metric sides of the ruler. The protractor required more patience. Tiles and cubes are no longer one unit of measure. Children now use them as a reference point. Now a tile can represent twenty miles and a cube can represent one hundred and fifty people or two thousand barrels of oil. Reading and interpreting graphs makes sense.

I also found that while instructing children in graphing, using data about themselves and children their age was far more interesting to them. The children enjoyed making surveys and graphing the results. To make this more interesting, probability was introduced. Using materials such as coins, dice and spinners, children learned to make predictions based upon possible outcomes. Because children had to tally each draw, toss or spin and then graph it, they now understand terms such as sample, frequency and ratio.

Some unexpected improvements in the areas of mental math, estimating, reasoning and computation occurred. The questions many of the children ask also indicate some higher level thinking. When the children are actively engaged in a problem solving and decision making activity, discipline is of less concern.

Finding success using these fairly inexpensive materials to teach simple geometric concepts and statistics, I began to look for other math materials that would help children better understand Social Studies concepts. I added meter sticks and conducted a lesson on the appropriate measure for various objects. This also reinforced the concept of scale. At the same time, by measuring the classroom and the hallway, the children physically experienced what a kilometer was not, but was better able to estimate places a kilometer away.

Another item I have added is demonstration thermometers. While preparing a lesson on climates, I discovered another use for them. They provide a visual of negative and positive integers. Simply bringing this to the students attention; directing them to manipulate the ribbon; and record their

findings created a flourish of excitement and a lively discussion.

Finally, I have an activity that is my own invention. I developed it years ago to help youngsters learn longitude and latitude. I call it the Bugga Genie. My Math colleague calls it coordinate geometry. The object is for the children to locate certain parts of the genie on the grid and make a dot. They then write the part and numbers of the intersecting longitudinal and latitudinal lines. This activity has worked well and the children get a real kick out of it.

These experiences have made me eager to discover more ways to bring math into the Social Studies classroom. In fact, I have been trying to figure out a way to convince my administrator that the children are not too young for a class set of graphing calculators and that is not an insane request from a Social Studies Teacher!

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